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CLEARING LAND

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METHODS OF CLEARING land that have proved successful in the cut-over sections of the United States are presented briefly in this bulletin. Various methods of burning stumps and different types of mechanical stump pullers are described, the advantages of the use of dynamite are set forth, and approved methods of pasturing stump land to keep down sprouts are outlined.

On many farms at the present time there are small tracts of woodland that might be profitably cleared. When such operations can be undertaken in spare time and without interruption to regular farm work, farmers can profitably increase their tillable area.

CLEARING LAND.

CONTENTS.

CUT-OVER LAND, or land from which the stand of merchantable timber has been removed, may be found in all of the timbered States, but most of our cut-over acreage is located in the Southern States, where there are over 100,000,000 acres; in the Lake States, where there are over 30,000,000 acres; and in the Northwestern States, where there are over 8,000,000 acres. On much of this cut-over land there is at the present time sufficient valuable second growth to warrant keeping it for permanent timber land. Also, much of the cut-over land lying idle has a greater relative value for timber than for crop production, and steps should be taken to establish a valuable forest growth; but there are in the aggregate great areas of good cut-over land in farms lying idle—not even growing timber—that is worth more for crop than for timber production. On thousands of farms throughout the cut-over sections the most vital problem in normal times is how to get this unproductive land cleared so that it will bring in an increase of revenue. On many farms in the East and Middle West there are tracts covered by woods and brush that are better adapted to crop production than to forest growth.

This publication does not attempt to decide the important question whether or not any particular tract of land will pay better in field crops than in forest. It simply presents as briefly as possible some of the methods of clearing cut-over lands that investigations by the Office of Farm Management have found to be successful.

Most cut-over land passes through three stages of development before it reaches its greatest value agriculturally. The waste and small growth is first disposed of. It then remains in stumps a few years until the smaller stumps are dead or decayed, during which time it is pastured or may even be cultivated. Finally all the stumps are removed.

DISPOSAL OF WASTE AND SMALL GROWTH.

If there is a great amount of worthless growth, it should be cut and piled before the valuable growth is removed.[1] In most cases, however, this is not necessary. The best time to cut is when the trees are in full leaf, since then the stumps are least likely to sprout and the leaves on the trees assist materially in burning brush. Probably most second growth, however, is cut in the winter or early spring because there is always more spare time then than at other seasons

FIG. 1.—A small drag-saw outfit operated by one man. This is used to saw the big trees of the Pacific Northwest into firewood. It is mounted on skids and is pulled along for each new cut by means of a winch and cable.

of the year. In some cases it is advisable to leave part of the growth on a tract, because of its value as a windbreak, shade for stock, or a preventive of soil erosion.

Generally it is best to cut brush as close to the ground as possible and avoid leaving sharp points on the stubs that might injure work stock or cattle. If the wood is of no value and if it is not planned to cultivate the land before stumping, it may be best to cut off the trees rather high above the ground. If stumps are left 3 feet high there will be less sprouting than if cut close to the ground, and stumps left at that height may be more easily pulled.

[1] See "Measuring and Marketing Woodlot Products," Farmers' Bulletin 715, Division of Publications, U. S. Department of Agriculture, Washington, D. C.

Sometimes it is economical to deaden part of the large, worthless trees by girdling. (Fig. 2.) There will be the least sprouting if this is done when the trees are in full leaf.

In parts of Florida there is often a dense growth of palmetto. The palmetto roots are usually grubbed out by means of a mattock and piled and burned with the worthless timber.

The brush should be heaped into compact, conical piles. It is important to pile the brush close in order to get a good burn. If the brush is piled in windrows it is a good plan to run the windrows so

FIG. 2.—This land has been in cultivation six years. All the small stumps have decayed. These gum and oak trees were not worth removing. They probably will remain on the tract until they fall over. Note how deeply the trees have been girdled.

that neither side will be in the shade all day and as nearly parallel to the prevailing winds as it is possible to run them and still permit the sun to shine on both sides. This facilitates burning.

In most cases the worthless logs should be burned at the same time as the brush. On the Pacific coast, however, owing to the great amount of such material left on the ground, it will be practically impossible to burn all the logs when the slashings are disposed of. When it is the intention to burn the stumps in the ground it is advisable to leave enough logs for fuel.

In some places the brush is burned as soon as cut. Ordinarily it is well to wait until it is seasoned. The safest time, if not really the

best, to burn slash is after the summer or fall rains. A great deal of burning is done during dry times in summer, but many destructive fires are caused by carelessness in brush burning. In some States brush burning is prohibited, and some State laws hold a brush burner liable for damages if, through negligence, he allows fire to escape from his property.

Settlers clearing land in or near national forests should notify forest officials before proceeding to burn brush, and in all districts having a fire warden a permit from him should be obtained before

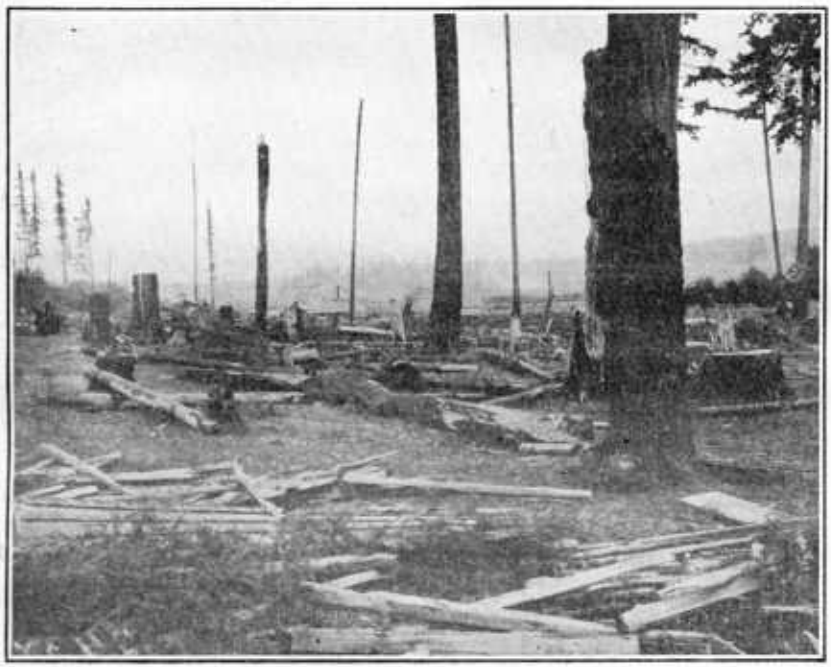

FIG. 3.—Logged-off land in western Washington. This land has been slashed and burned and is used for pasture.

any burning is attempted. In all cases ample precautions should be taken to prevent the spread of fire.

Growth on swamp land or any soil containing a large amount of organic matter should be burned when the ground is wet to prevent the destruction of valuable plant food. When soils do not contain a large amount of organic matter and it is the intention to seed in the ashes immediately after the burning, too much emphasis can not be placed upon the importance of getting a clean burn.

PASTURING STUMP LAND AND KEEPING DOWN SPROUT GROWTH.

Land is usually pastured several years after the small growth is disposed of before it is stumped (fig. 3). When land is kept in

pasture for several years before any stumps are removed, many of the small stumps will entirely decay and the fibrous roots of the larger ones will have become so weakened by decay that it is much easier to remove them.

In order that the pasturage may remain good and the stumps decay it is very important to keep sprout growth down. Second-growth hardwood stumps, especially those of comparatively young trees, sprout very prolifically. (Large stumps of any species of tree sprout much less than small ones.) The most successful method of keeping down sprout growth is by heavy pasturing with goats, sheep, or cattle, in the order given. When goats are kept on a tract for about two years they will destroy most of the sprouts and briers.

Some make a practice of pasturing the new land with goats for a few years. After the goats have killed most of the small growth, and grass has begun to come in, dairy cattle are substituted. If goats are used in subduing the sprouts, it is unnecessary to cut all of the small growth.

Any sprouts not killed by pasturing should be cut off or knocked off with the head of an ax. Whenever possible it is best to cut sprouts several times during the growing season, the object being to starve the roots. If this can be done only once during the growing season, it should be done in the late summer.

In most cases after the tract has been burned over it should be seeded lightly. Generally, however, one is not warranted in spending much over $1 per acre for grass seed. On many tracts, particularly those of the Pacific Northwest region, grass seed is sown in the early fall following a burn and before the ashes have been settled by rains.[1] In the Lake States the usual procedure, if the burn is made in the summer, is to harrow or disk immediately after burning and then sow timothy. The following spring when the snow is 1 or 2 inches deep, or as the frost leaves the ground, clover seed is sown. Sometimes all the grass seed is sown in the spring.

In the longleaf pine belt the land is burned over each year to improve the pasturage. Wherever Bermuda grass will grow a pasture may be started by digging up the roots from an established field and transplanting them to the new land late in the winter.

On the Pacific coast many logged-off pastures may be considerably improved if the ferns that infest them are cut and burned about August each year.

If the weeds and sprouts in a pasture are kept under control, native grasses will gradually establish themselves even if no seeding has ever been done.

[1] More details regarding pasturing may be found in "Utilization of Logged-Off Land for Pasture in Western Washington and Western Oregon," Farmers' Bulletin 462, for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

In some places there is such a large amount of worthless logs on the ground that some of them must be disposed of before the land can be pastured. Often it is advisable to stump the land partially while it is in pasture.

CULTIVATING STUMP LAND.

In the South, where usually the natural pastures are poor, it is the custom to cultivate the stump land instead of pasturing it. Another reason why stump land in the South is more generally cultivated than elsewhere is that most of the stumps there are tap-rooted and have few large lateral roots to interfere with tillage operations.

In some areas of the southern pine belt there is very little small growth to be disposed of. An easy method of getting this land into cultivation is to deaden the larger worthless trees, cut the small growth, grub out the small stumps, and burn. Later the deadened trees may be removed and the stumps taken out.

PULLING STANDING TREES.

Often it is advisable to clear the land completely at once. In that case it may prove to be most economical to remove entire trees without cutting. An important objection to this method is the great amount of work required to clean the earth from the roots of the green tree. In all except very sandy soils this is a hard task.

It is easier to pull a standing tree than it is to pull the green stump of the same tree, because a hitch can be made high on the trunk of the tree to give a powerful leverage on the roots. However, unless the trunk is rigid enough to stand the strain of pulling without bending, it is a waste of time to try to pull a tree in this manner. Ordinarily the hitch should be made about 4 or 5 feet above ground, though if one is pulling large trees with a hand stump puller the hitch can be made 15 or 20 feet above ground. It helps to place against the trunk of the tree a heavy block of wood to act as a fulcrum when the tree is pulled over.

If some of the roots are cut with an ax as the tree gradually bends over it may be pulled out with considerably less power. Trees may be pulled by any of the methods of stump pulling described later.

PLOWING SMALL GROWTH UNDER.

Small growth up to about 3 inches in diameter can be plowed under by the use of a very heavy special plow, drawn by a powerful traction engine. These plows turn a furrow 12 to 18 inches deep and about 2 feet wide and the engine assists materially in crushing down the taller saplings. This method should be used only where the soil is of such a nature that plowing it to that depth will not

cause any injury and where the clearing operation is large enough to warrant buying such a heavy outfit.

REMOVAL OF STUMPS.

Stumps occupy valuable land; foster the growth of weeds, since in order to keep the land in their vicinity clean much hard labor is necessary; mar the appearance of otherwise smooth fields, and hence reduce the selling price of a farm; furnish shelter for harmful insects and animals; and prevent the efficient use of modern machinery.

Stumps may be removed by burning, by explosives, by mechanical means, or by a combination of any or all these three methods. There is no "best method" of ridding land of stumps, and the selection of a method for their removal should be determined only after a consideration of factors involved.

Most hardwoods decay so that they can easily be removed within 10 years from the time of logging, provided the stumps are kept from sprouting. Most pine and fir stumps, on the other hand, are very resistant to decay. Their main roots will remain sound a lifetime. The small roots of any stump will decay in a few years and with them out of the way the cost of stumping is reduced.

Often it is best to stump the field partially rather than to attempt to get all the stumps out at one time. For instance, in a field where there are a few very large stumps scattered about and many smaller ones, it might be advisable at first to remove only the smaller ones. Sometimes just by the removal of a few troublesome stumps that obstruct the way one can do fair work in cultivating a stump field.

It is usually considered more expensive to remove a stump that has burned to the surface of the ground than a similar sound stump. In order to pull such a burned stump it is necessary to dig the earth away in order to attach the pulling cables, or if a root hook is used considerable time will be lost in getting each root separately. If a burned stump is to be removed by dynamite, several charges will be necessary. With the unburned stump a single charge of explosive is usually sufficient to shoot it clear of the ground or to crack it so that it can be removed with a puller.

It also requires less power to pull a portion of a stump with a sound top than a similar portion without such a top, because of the greater leverage which can be obtained by hitching at the top. When the top of a stump is decayed and the roots are still sound, it is as hard to remove as one burned to the ground.

Tap-rooted stumps that can not be burned in the ground may be pulled entire or shattered with dynamite and pulled, or else blasted clear of the ground by explosives. If blasted, the dynamite would best be placed in a hole bored in the tap root. When an electric blasting outfit is used good work can be done by placing charges on opposite sides of the tap root and firing simultaneously.

BURNING STUMPS IN THE GROUND.

Destroying stumps by means of burning has been practiced from the time the first settlers in this country started to clear the land. One advantage of burning stumps where they stand is that there is no unwieldly stump left to handle after the operation is completed. It also requires practically no cash outlay and can be done by comparatively unskilled labor. Most of the land clearing is done by settlers and their families in their spare time, so the amount of time required to burn the stumps is not an important factor for them to consider.

The objections to all burning methods are the large amount of hand labor required and the fact that it is generally rather difficult to burn the roots below plow depth. In some fields cleared by burning methods, the roots are so near the surface that it is impossible to plow without striking many solid roots. The owners of these fields say that they would rather work a field with the stumps where they can see them than to have the ends of the big roots hidden just beneath the surface. However, it is always possible to burn all of the roots below plow depth if one is willing to take the necessary pains.

When burning stumps it is well to bear in mind that most stumps stand on a slight elevation of ground and that when the land is leveled the roots might be at the surface where previously they were even a foot below ground. Therefore the roots should be burned considerably deeper than one ever expects to plow. The writer once visited a tract where the stumps were being burned as described below in the two-hole method to a depth of 18 inches. The contract price for burning was 10 cents per stump and the owner measured the depth to which each stump was burned and did not pay unless the stump was consumed to that depth.

The following methods have all been successfully used in various parts of the country:

Two-hole method.—The following method is very effective for seasoned longleaf pine stumps of the South: Two holes are dug on opposite sides of the stump down the taproot to a depth of about 30 inches. Generally connection is made at the bottom of these holes by digging away the wall of earth between them. Any adhering earth is scraped from the taproot. A fire is then started in one of these holes. In case the two holes are not connected, fires are started in each of them. There is usually sufficient fuel on the ground to keep the fires going. Some usually can be split off the stump. After a stump is burning well it requires little attention until the taproot is burned off. Most stumps can be burned thus in one or two days. Usually the small lateral roots will also be burned so that after the holes are filled the ground may be plowed without striking any roots. The burning should be done when the land is comparatively dry.

Under favorable conditions, one man is able to burn by this method about 100 stumps a week.

One-hole method.—Another method of burning that has been successfully used in the longleaf pine area of the South is to dig a hole on one side of the stump only. This should be dug at least 20 inches deep and the adhering earth on the taproot scraped off, so that the fire will come in contact with the stump. A 1½-inch or 2-inch auger hole is then bored diagonally through the stump into the hole from

FIG. 4.—Burning a longleaf pine stump as described under Dynamite method. This stump is 22 inches in diameter and was cracked by the use of one-half pound of 40 per cent dynamite. The soil was slightly heavier here than is usually found in longleaf pine land, and it was found unnecessary to dig as deep a trench around the stump in order to induce burning to below plow depth as in places where the soil is sandy.

a few inches beneath the surface of the ground on the opposite side of the stump. A fire is then started in the excavation and the auger hole serves as a flue. After a fire is well started the stump usually requires very little further attention.[1]

Dynamite method.—This method is used for burning the longleaf pine of the South and could be used for the yellow pine of the Mountain States. It is often successful where the two- or one-hole methods have failed. A trench about 8 inches deep is dug entirely around the stump. A 1½-inch hole is then bored, starting near the

[1] A hand-operated boring machine that does effective work is described in "Clearing Pine Lands," Mississippi Experiment Station Bulletin No. 159. Agricultural College, Mississippi.

bottom of the trench and extending downward at an angle of about 45°, slightly past the center of the taproot of the stump. In this hole a small amount of dynamite is tamped and exploded. The dynamite is used simply to crack the stump (fig. 4). From one-half to a whole stick (one-quarter to one-half pound) is sufficient to crack a 20-inch stump so that after a fire has been started in the trench it will burn without further attention to slightly below the bottom of the trench. The hole in the taproot may be bored with a hand auger or by means of a hand boring machine.

Cross-hole method.—This method has been more largely used in the Northwest than in any other region. A hole is bored horizontally into the base of the stump to a point a little beyond the center. Another hole is started as high up on the side of the stump as possible and bored downward at an angle until it meets the hole first bored. A fire is started at the intersection of these holes by the use of oil, pitch, coals, or by dropping a hot iron attached to wire into the hole. The fire is kept going at first by the use of a small hand bellows. The fire is kept confined in the stump as long as possible and when it breaks out logs and trash are added. By this method the top of the stump can be burned and the large roots burned a short distance below the surface of the ground. The roots can then be burned slightly further into the ground by digging the earth from around them and boring into them, or also by simply adding plenty of fuel after the earth is dug away. Often the roots are bored and then shattered by exploding dynamite in the bored holes. Sometimes the roots are blasted out by shooting each one separately. The electric blasting machine is best for this purpose. Some pull the roots by means of a stump puller, or blocks and line. There is a great temptation to stop burning before the roots are consumed below plow depth. This method requires much hand labor and a considerable amount of fuel. Sometimes the upper hole is started at the top of the stump and bored vertically downward through the center of the stump to a depth of a foot or more below the surface of the ground.

Northwest method.—This method is used principally in the Northwest. A small charge of explosive is set off under the stump. This should be just enough to crack the stump (fig. 5). The cavity underneath is then enlarged somewhat, some earth is dug away from the larger roots, plenty of fuel thrown in and a fire started. The burning is kept up as long as possible. Any roots remaining above the plow line are removed as described under the cross-hole method. Less hand labor is required than for the cross-hole method, and the roots are consumed to a greater depth.

Decapitation method.—The top of the stump is sawed off at the surface of the ground and lifted a few inches on blocks or stones.

After the stump is thoroughly dry a fire is started in the center of the stump and covered up with earth for charpitting. (See Charpitting.) As the burning continues the top settles down so that both parts of the stump are in close contact and do not allow the fire to cool. The Idaho Experiment Station[1] reports that "The stump will continue to burn slowly until the roots are practically all consumed if the land is not too sandy. This is one of the best and cheapest methods for removing stumps of red fir and yellow and white pine; it is somewhat more difficult to fire other species by this method, yet it can

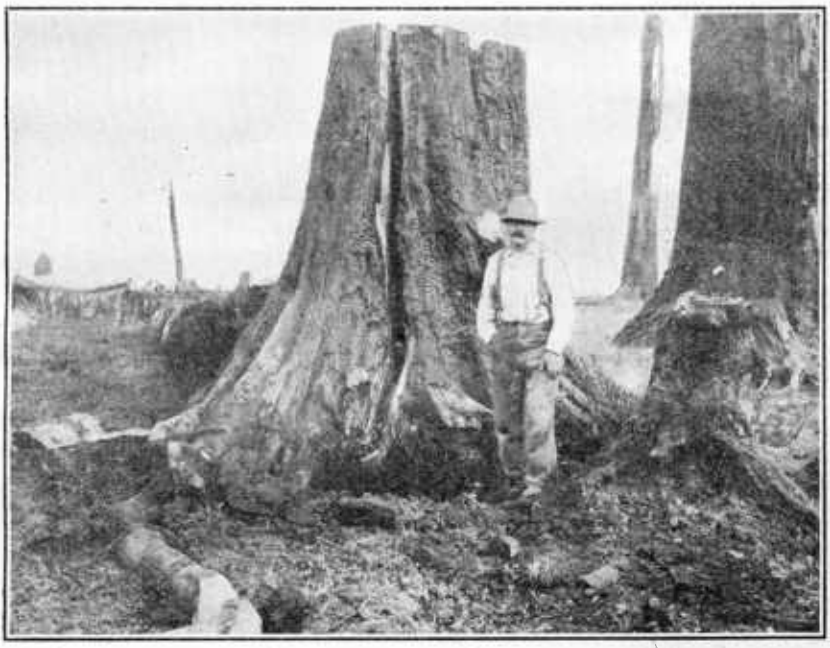

FIG. 5.—This stump was cracked for burning as described under the Northwest method. Six and one-half pounds of dynamite were required.

be done." This method has been used in other sections with less success than in Idaho, the principal objection being that the roots of the stumps are not burned below plow depth.

Charpitting.—A method of burning that has been successfully used with fir stumps in clay soil in the Pacific Northwest is known as charpitting. In the spring, when the ground is soft, a shallow excavation is made between two large roots close to the stump and the bark is removed from the base of the stumps and the roots. In the summer when the stumps are thoroughly dried a large armful of wood is thrown into the excavation and fired. After the fire is well started it is covered with earth to a depth of 2 or 3 inches, care

[1] "Methods of Clearing Logged-Off Land," Idaho Experiment Station Bulletin No. 91, University of Idaho, Moscow, Idaho.

being taken that the earth does not put out the fire, and yet covers the fire well enough to confine most of the heat. As the stumps burn new covering is added each day to keep the fire covered at all times, thus retaining the heat. Stumps require considerable attention the first two or three days, but after that they need to be visited only twice a day. Most stumps will be burned up in two weeks, though some will burn for two months before being consumed. It is important not to allow the fire to go out, because it is rather difficult to start it again. Often, instead of excavating between two roots, a ring of wood is put around the stump, covered with ferns to keep the earth from sifting through and all the wood is covered with earth except a small opening where the fire is started. By this method a stump may be burned out more quickly than if fired at one point, but considerably more fuel is required. To be sure of success with the charpit method the soil must be of such a texture that when heated it will bake instead of crumble. The stumps must contain enough pitch to burn well, the season must be such that the stumps are dry when the work is started, and there must be very little rain during the period of burning. Attention to covering the fires at the right time is equally important. Under favorable conditions where a large number of stumps are burned at one time, it has taken about two hours of labor per stump to burn out the average 36-inch fir stump.

Air-blast method.—Several devices have been put on the market to accelerate the burning of stumps by means of supplying blasts of air to the fire. Some have attachments to spray oil into the flames at the time of burning. The operators of these outfits have found it very difficult to burn the roots below plow depth. It has been found possible to burn stumps by this method, but the process was so slow and costly that it has been practically abandoned.

Hood method.—Burning stumps by covering them with a hood has been used to a very limited extent for about 50 years. About 20 patents have been issued to inventors of these devices. These hoods are not in general use because of their high initial cost and comparatively short life, the great number required to do a piece of clearing owing to the slowness of burning, the difficulty of handling them, and, the most serious objection of all, the fact that by their use it is very difficult to burn the roots beneath the surface of the ground. In order to burn the roots it is necessary to dig the earth away from them to as great a depth as it is desired to burn them. This is a slow, laborious process. It seems to be as easy to burn out a stump by any of the previously-described methods as it is to use a hood in combination with them. If a hood could be constructed of such material that the radiation of heat generated within could be largely prevented, and yet be durable and not too expensive, it might be successful.

EXPLOSIVES.

Explosives can be used to advantage in clearing most land. Either alone or in combination with burning methods or pullers, explosives, if used efficiently, will materially reduce the cost of stumping.

Dynamite is a means of rapid clearing, and when it is used there is no capital tied up in idle machinery after the clearing is completed. If it is not possible to reduce the acre cost for stumping machinery to a reasonable figure, blasting is the most economical method, except perhaps the burning methods, to use in stumping small tracts. If in doubt whether to use dynamite alone in stumping it is advisable to get a 25 or 50 pound box and experiment to find how much it requires to blow out some average stumps on the tract. However, it is usually found more economical to use dynamite than to depend upon labor for doing the work.

It is difficult to clear the earth from the roots of stumps in clay soil. Where stumps are shot clear of the ground there is less adhering earth than where they are cracked and pulled. Perhaps in clay soil it would be more economical to shoot the stumps clear of the ground.

If explosives are bought in small quantities the cost is rather high. To reduce the cost it is recommended that several farmers club together and buy in large quantities. Careful, experienced persons can safely do the work with high explosives, but no one should attempt to use them until he thoroughly understands the best and safest methods of handling. Various brands of explosive require different methods of handling, and full and detailed information as to the best ways of using them is absolutely essential. For this reason, the reader is advised to study with extreme care the instructions issued by the manufacturer of the brand of explosive which he proposes to use.[1] If dynamite is to be handled in cold weather, study very carefully the manufacturers' instructions on thawing dynamite. Many accidents have happened through ignorance or carelessness in thawing. The blasting caps are much more sensitive than the dynamite itself, and should be handled with great care. A cap crimper is an inexpensive tool, and its use may prevent serious accidents.

The best time to blast stumps is when the ground is saturated with water. The explosive works most efficiently then because the gases resulting from the explosion do not escape through the spaces be-

[1] The following State publications give some information on the use of dynamite:
"Blowing Stumps with Dynamite," Kentucky Agricultural Experiment Station Bulletin No. 154, Lexington, Ky.
"Land Clearing," Minnesota Agricultural Experiment Station Bulletin No. 134, University Farm, St. Paul, Minn.
"Investigations in Costs and Methods of Clearing Land," Minnesota Agricultural Experiment Station Bulletin No. 163, University Farm, St. Paul, Minn.
"Methods of Clearing Logged-Off Lands," Washington Experiment Station Bulletin No. 101, Pullman, Wash.
"Use of Explosives in Clearing Land," Wisconsin Experiment Station Bulletin No. 216, Madison, Wis.

tween the soil particles, and the roots of the stumps will slip out of the earth easily.

An explosive containing a low percentage of nitroglycerin will do the same work in wet soil as one containing a higher percentage would do in the same soil when dry. Dynamite with 20 per cent of nitroglycerin or its equivalent is used almost exclusively on the Pacific coast. It could be used effectively for stumping operations in many other parts of the United States, especially where the soil is heavy, wet, or where the stumps are well decayed. Dynamite with 40 per cent nitroglycerin is largely used in the South for blasting the longleaf pine, and in the Lake States for white pine. In many cases a lower grade of explosive could be profitably substituted. The 40 per cent grade should be used where the soil is somewhat light and dry or where the stumps are green. The 60 per cent grade of dynamite has been used with good success in blasting stumps in the porous coral soils of southern Florida, in blasting stumps at a dry time in sandy soil, and in blasting tough, green, hardwood stumps. The higher percentage dynamites are likely to pack heavy soil if used when it is very wet.

Roughly, the number of pounds of dynamite required to shoot a stump clear of the ground is the same as the square of the number of feet in the diameter of the stump at the cut-off. For example, a 2-foot stump will require 4 pounds, and one 6 feet in diameter will require 36 pounds. Often less will do the work, but occasionally more is required. All factors, such as kind and soundness of the stumps, and kind and condition of the soil, influence the amount of explosive required for a stump of given size. Loud reports and the throwing of parts of the stump high in the air indicate an excessive charge.

Firing charges by electricity.—The electrical method of firing blasts is beginning to be extensively used. In firing charges by this method the following equipment is needed: One blasting machine, 300 feet of double leading wire to reach from the stumps to the blasting machine, some connecting wire to connect the stumps together in a series, and electric detonators in place of the caps and fuses used in ordinary blasting. Firing by electricity has many advantages over the cap and fuse method. The danger of premature explosions is greatly reduced, and the danger from delayed explosions is entirely eliminated. Probably more people have been injured in stump blasting by too hasty investigation of a delayed explosion than from any other cause. When using the cap and fuse method, the safe rule to follow when a charge does not explode as expected is to keep away from the locality until the next day. Where the stumps have been severely burned, are badly decayed, hollow, have several large spreading roots, or where it is necessary to blast

stumps so near to each other that the explosion of a charge under one stump would loosen the earth under the adjacent one, the use of the blasting machine will save dynamite and result in better work being done than if the cap and fuse are used. If the stumps have been partially burned out by any of the burning processes previously described, the roots can best be blown out by firing the charges with a blasting machine.

STUMP PULLERS.

As a rule, the farmer who is clearing land has little ready money to spend. The method that appeals to him most is one that requires a minimum cash outlay for explosives, is fairly rapid and effective, and will permit the use of teams and family labor. For clearing small areas the economy of buying a stump puller is questionable. From one-fifth to one-half the explosive required to shoot a stump clear of the ground will break it up so that it may easily be pulled by the use of a stump puller. However, stump pullers are expensive, some of the good ones, complete, costing $200 or more. Now suppose, for example, that trials indicated that it would require 40 cents less for dynamite to crack the stump so it could be pulled by the use of a puller, than it would to shoot it clear of the ground, and a count showed that 500 stumps were to be pulled. It is obvious that it would not be economy to pay more than $200 for a puller unless one were sure of selling it at a good price after completing the work.

Several ways have been suggested for lowering the acre charge for use of the stump puller. Often secondhand machines can be purchased or hired cheaply. Sometimes one can sell a puller at a fair price when it is no longer needed. Several farmers might purchase one in partnership. Commercial clubs, townships, or county officials interested in the development of cut-over lands could purchase such an outfit and rent it to those clearing land. Probably $2 a day rental, with the understanding that the party renting would be responsible for any damage and for losses of chokers or small parts, would be a fair charge.

Most manufacturers of stump pullers furnish detailed instructions for operating their machines, and illustrations of various time- and labor-saving methods of making hitches, so little attempt has been made in this publication to go into detail concerning these points. Only a general discussion of the types of pullers is given in the following pages.

There are two general types of stump pullers, those that pull the stump from the side and those that lift it vertically out of the ground. The capstan pullers pull from the side. Most of the horsepower and some hand-power machines are of this type. All steam and gasoline power outfits pull from the side. The tripod machines lift the stump

vertically. These are mostly horsepower machines, though there are some hand-power tripod machines.

CAPSTAN STUMP PULLERS.

With the capstan type of puller, an acre or more of stumps can be pulled at a single setting (fig. 6). This feature saves considerable time and makes the capstan type efficient for pulling small stumps like scrub oak, jack pine, alder, and others. Where small, sound stumps are pulled, considerable time is saved by using cluster ropes

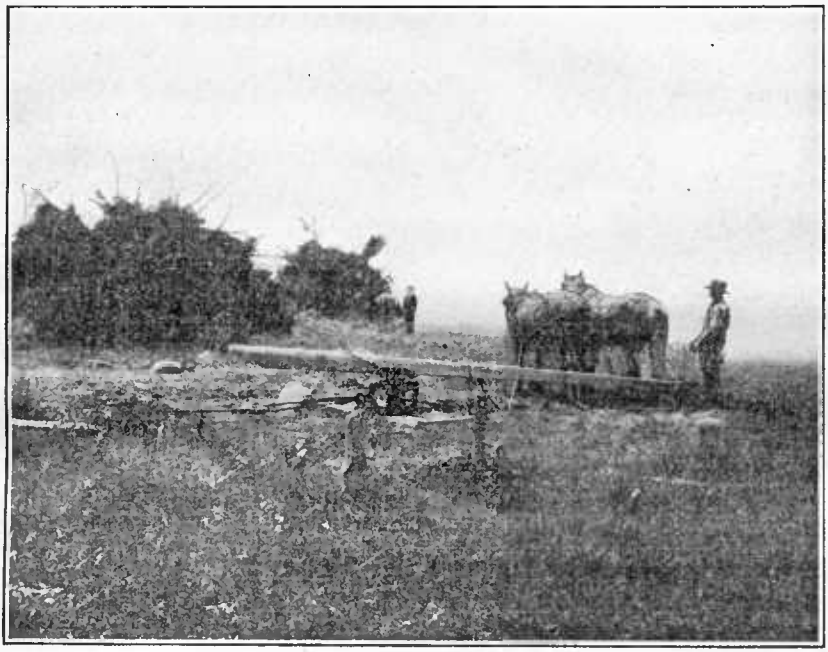

FIG. 6.—Pulling white pine stumps by means of a capstan puller. If these stumps had been shattered by dynamite before pulling, less earth would have adhered to the roots.

and cable take-ups. In getting scattered roots or stumps where the tops are burned off, it is advisable to use a good root hook which will largely obviate the necessity of digging out each root before the cable can be hitched to it.

The capstan machine will work on steeper land than the tripod, though no horsepower machine will do very efficient work on a steep hillside. In stumping hilly land set the capstan as near the anchor stump as possible and place the anchor cable in notches cut at the ground line of the anchor stump. By using the double and triple power arrangements of lines, the capstan machines will pull very large stumps.

It is becoming the practice, however, in most sections to split all the largest stumps by means of dynamite rather than to attempt

to pull them by the use of extra power blocks and cable. This does away with adjusting blocks and hauling extra cable, reduction in speed of pulling, and the difficulty of disposing of the large stumps. Also the use of dynamite will shake the stump sufficiently so that the earth may be quite easily removed from the roots. Most farmers, however, will need extra blocks and cable for some cases where poorly placed charges of dynamite have not loosened the stump sufficiently so that it may be pulled whole or in pieces by direct pull.

Medium-sized machines are usually more satisfactory than large ones, since the latter are cumbersome to handle and are expensive. Three men and a team make a good working crew in operating one of the capstan machines.

Horsepower capstan stump pullers cost complete from $75 to over $250. If they are given average care there should be very little expense for repairs to the machine. The cables will wear out before the machine, but with proper care should last as long as the average farmer would need them to clear his land. Kinking the cable, or breaking the strands by running through small blocks, or cutting it by improper hooking causes it to wear out rapidly. Using the puller when it is wet causes the cable to rust and dragging it through the mud grinds the cables.

Plow-steel cable is generally used for pulling stumps. The $\frac{3}{4}$-inch cable has a working strain of 5 tons; the $\frac{7}{8}$-inch cable, 6.8 tons; and the 1-inch cable, 8.8 tons. The breaking strain is five times the working strain. The $\frac{3}{4}$-inch and $\frac{7}{8}$-inch cables are most extensively used.

TRIPOD STUMP PULLERS.

The tripod stump puller (fig. 7) has been quite extensively used for pulling large scattering white and Norway pine stumps growing in sandy soil in Michigan.[1] They are also used, to a limited extent, in the Mountain and Pacific Coast States and in some parts of the South. They have proved to be a very satisfactory puller for use in the Lake States. There are three patterns, screw, windlass, and lever machines. The lever machines are most widely used. Any stump is pulled more easily when lifted vertically than when pulled from the side. No anchor stump is required for this type. The puller is moved for each stump, as it is necessary to set the machine directly over the stump to be pulled. The stump is lifted by chains passed around one of the larger roots. The tripod types of vertical lift machines are very powerful, and in Michigan few contractors ever use dynamite to assist in pulling. It is well to keep in mind, however, that in most cases where the tripod has been used the soil was so

[1] For more details concerning these pullers see "Costs and Methods of Clearing Land in the Lake States," U. S. Department of Agriculture Bulletin No. 91. For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5 cents.

sandy that the adhering earth could be easily cleaned from the roots of the stump.

Pulling a stump with a tripod machine leaves practically no hole to be filled, because the earth when cleaned from the roots of the stump falls into the hole made by the removal of the stump. Four men with four horses make a good working crew. Data have been secured showing that on five tracts of land the crews averaged 79 stumps per day for over 140 days.

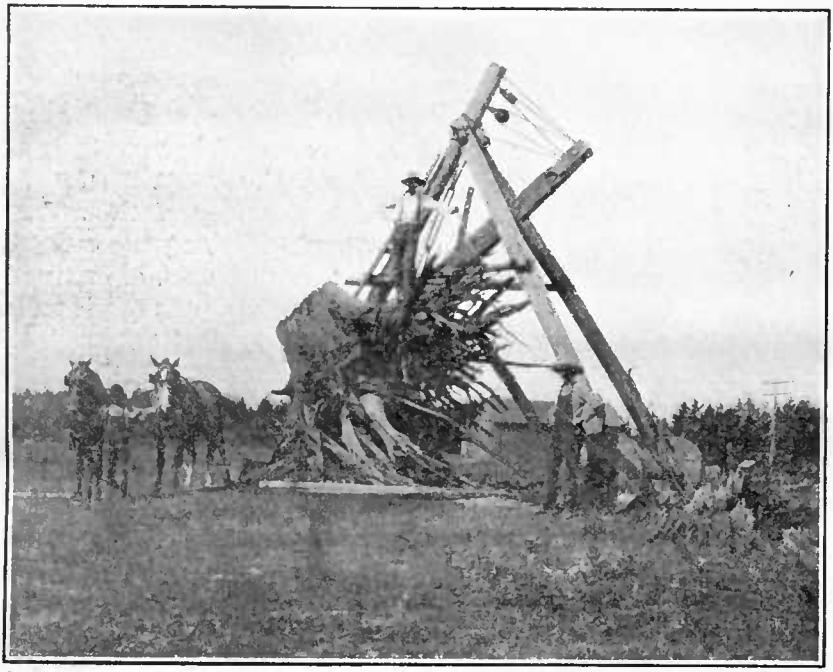

FIG. 7.—A tripod stump puller. This crew pulled and cleaned an average of 15 stumps a day. No dynamite was used. The stump is a white pine. The soil is a light sandy loam. This tract has been logged 45 years. The roots were used for fuel. Most of the tripod pullers are mounted on skids and are handled by a crew of four men and four horses.

When pulling stumps growing in heavy soil with these outfits it is advisable to crack the stump with dynamite before pulling, because it very greatly reduces the amount of labor required to clean the earth from the roots.

The tripod machines cost from $125 to $200. The screw machines are very durable. The cables of the windlass and lever machines will break in time, but otherwise there should be but little expense for repairs. The manufacturer of one of the lever machines states that on the average a cable will last to pull 6,000 stumps before wearing out.

HAND STUMP PULLERS.

There are two types of these machines, one of which pulls the stump from the side and the other of which lifts the stump like the tripod horsepower pullers. The hand stump pullers usually cost less than the horsepower pullers. While it is possible for one man to operate them, two men can do more efficient work than one.

In pulling standing trees or in pulling stumps in locations where logs, tree tops, or other obstacles would prevent the use of the horse machine, the hand stump puller is very efficient (fig. 8). It also has an advantage over the horsepower puller in that it can be operated

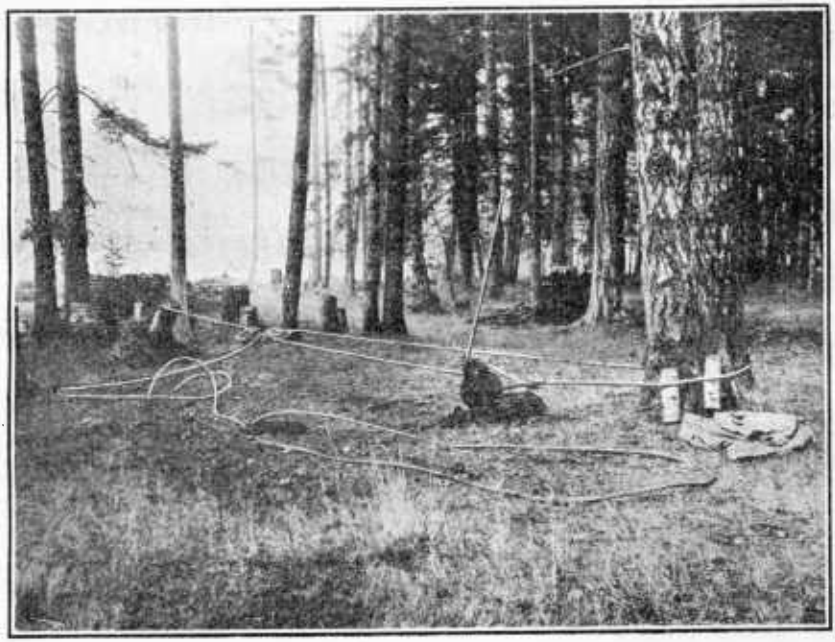

FIG. 8.—Pulling a second-growth fir stump by means of a hand stump puller.

in almost any position, while the pull of the latter machine must be in a nearly horizontal position, otherwise it is likely to be overturned. For that reason hand stump pullers can be operated on very steep land and less time is required to set them up than to set up horse machines.

With all of the hand stump pullers speed must be sacrificed for power. Even then it is necessary to use blocks and cable when pulling large stumps, and besides making the operation of the machine much slower, the adjustment of blocks and cable takes much time. In order to pull a stump without the use of extra blocks and cable it is necessary to shatter it well with dynamite.

The more slowly a stump is extracted from the ground the less the roots are broken off in the ground. For that reason one is likely to

leave fewer roots where a hand puller is used than where a donkey engine or dynamite is employed.

As a general proposition, horsepower is cheaper than man labor. Where a horsepower machine can be used, stumps can be pulled more cheaply by it than by a hand-power machine. Most farmers who are stumping land have teams, and instead of allowing them to stand idle and hiring laborers to do the work of stumping, it is economy to use the horses. The hand stump pullers cost from $30 to about $200.

BLOCKS AND LINE.

Blocks and line can generally be used to good advantage wherever hand, horsepower, capstan, or tripod machines would be employed. When tackle is used for heavy clearing it is necessary to use somewhat more dynamite than when using any one of the other pullers. Blocks and tackle come in handy where dynamite is used, because in all such stumping operations there are usually some shots that do not remove the whole stump, or that leave in the ground some roots that are too solid to be removed by a team with a direct pull. In clearing swampy ground where the rooting system of the trees is very shallow, blocks and lines with a good team make a very satisfactory device for removing stumps. Usually stumps can be pulled more rapidly with blocks and lines than with a stump puller, though, as indicated above, more dynamite is needed to shatter the larger stumps.

Arrangements from a single block and line to a combination of two triple blocks are used. When the line of pull is parallel to the line of resistance one single block with line will increase the power twice; two single blocks, three times; one single and one double block, four times; two double blocks, five times; and two triple blocks, seven times. A good way to use several single blocks is to connect them in series, one after another. In this case each block may have a separate anchor. By this arrangement one single block (as before) increases the power twice; two single blocks, four times; and three single blocks, eight times. This arrangement gives greater efficiency than the one previously mentioned because there is less loss through friction, though it is more trouble to connect the lines in this manner, and heavier lines are needed.

Single blocks suitable for pulling stumps should not cost much over $2 each and triple blocks $4 each. Half-inch plow-steel cable, which has a working strain of 2.3 tons and costs about 12 cents a foot, is often used for line. Sometimes $\frac{5}{8}$-inch and occasionally $\frac{3}{4}$-inch cable is used. Ordinarily the blocks should be at least 10 feet apart when starting to pull. In this case when using triple blocks, about 80 feet of cable would be required. In addition to this, two pieces of $\frac{3}{4}$-inch cable will be needed, one about 10 feet long for a "choker," and the other 40 or 50 feet long to use for the anchor. This cable

should not cost over 25 cents a foot. Where one single block is used, 50 or 60 feet of ½-inch or ⅝-inch cable, with 10 feet of choker cable, which can be of the same size, will be all that is required. Hooks and eyes will be required on the cables.

The cost of tackle complete will range from $15 to $40, new. In case it is desired to use rope instead of steel cable, use nothing lighter than hemp rope 1 inch in diameter.

Blocks and tackle suitable for pulling stumps cost much less than stump pullers, and after the land is cleared they will be found handy for many other operations about the farm. Often secondhand elevator or logging cable and blocks, fit for use in pulling stumps, can be purchased cheaply of junk dealers.

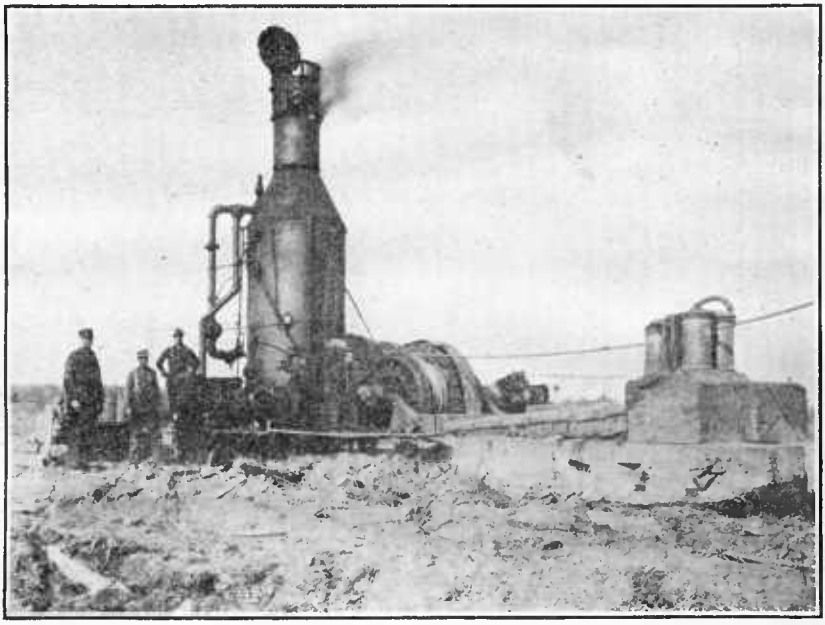

FIG. 9.—A powerful steam donkey engine used in land clearing.

In a test of blasting white-pine stumps in fairly wet sandy-loam soil in Michigan, it was found (figuring dynamite at $12.75 per 100 pounds and electric detonators at $4.70 per 100) that it cost 22 cents more to shoot clear of the ground the average stump 23 inches in diameter at the cut-off than to shoot it so that the pieces could be pulled by a team with block and line. Thus, a farmer with his team and equipment and hired man could earn $6.50 a day, in dynamite saved, if they pulled the pieces of 30 stumps a day.

In the test just described about 3 pounds of explosive was used to shoot the stumps clear of the ground and 1½ pounds to split them for pulling with team, blocks, and line. If the same work had been done on heavy soil the difference in cost between the two methods would

not have been so great, because less explosive would have been used and more work would have been required to clean the earth from the roots of the stumps pulled by the block-and-line method.

STEAM AND GASOLINE POWER OUTFITS.[1]

Power stump pullers have been used to a limited extent in the Lake States and in the longleaf pine regions of the South. A few machines have been successfully used in the bottom lands of Missouri and Arkansas. There they have been employed principally to pile worthless logs and small growth rather than to pull stumps. Some

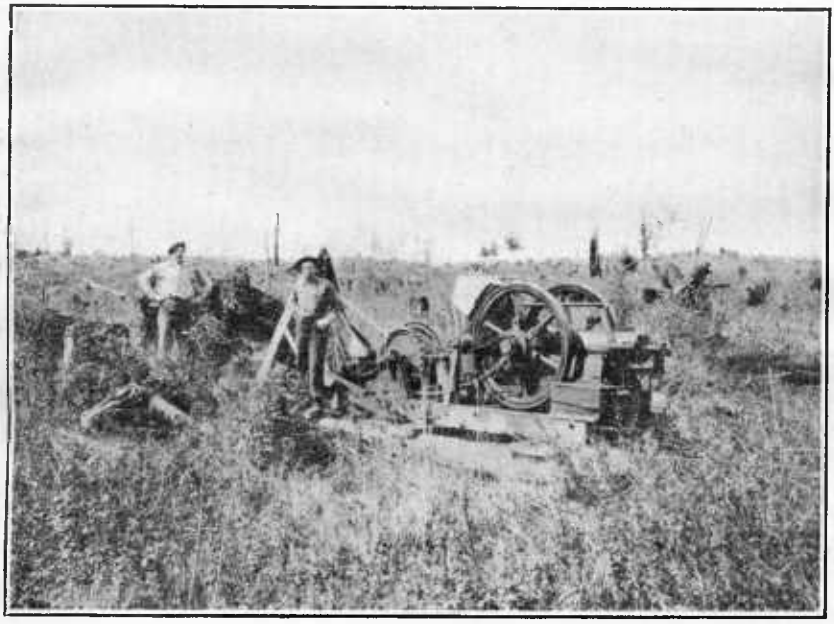

FIG. 10.—A small gasoline donkey engine used in pulling stumps.

of the steam donkeys (fig. 9) used for stumping have been especially designed for this work, but most of the clearing has been done with logging engines. The ordinary hoisting donkey engine has not been successfully used in this work. The most extensive use of donkey engines has been in the Puget Sound region. Here they have proved to be a cheap and successful method of clearing logged-off lands, especially those where there was a great amount of worthless logs and trash to be removed from the lands. It is necessary to use explosives in connection with these machines, since they have no greater pull than a good stump puller (fig. 10). The cost of these power outfits, however, is so great that they are beyond the reach of the average settler.

[1] For details of operation of these engines see "Costs and Methods of Clearing Land in Western Washington," Bureau of Plant Industry Bulletin No. 239; for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 10 cents.

Sometimes it is possible for a group of settlers to hire one of these outfits and exchange labor in clearing. Where this is possible, and they have a good engineer and a good man in the field to direct the work, they can do the work in a very rapid and efficient manner.

Some gasoline outfits are in use. They require about the same sized crew as a capstan stump puller, and with a good outfit efficient work can be done.

TRACTION ENGINES.

Traction engines or gas tractors have been used in a few places in various parts of the United States for clearing land. They have proved to be successful in removing small growth and well-blasted stumps.

If there is a probability that a tractor could be used with profit on the land after clearing, it would in many cases be advisable to purchase such an outfit at the beginning of the clearing operations. Usually the growth or stumps are removed by a direct pull. A chain or cable may be used for this work.

DISPOSAL OF STUMPS AFTER PULLING.

All pine stumps are rich in pitch and make excellent fuel. In many areas one could use the larger part of stumps for fuel.

On many farms there are deep gullies adjacent to the newly stumped fields and the stumps could be used to fill these. Adjacent to other fields are waste places which are worthless for farming and to which the stumps could easily be hauled. In the Lake States in the early days of clearing, many fences were made of pine stumps, but few such fences are being built at the present time. Where stumps have been well blasted it is relatively easy to handle them. In some sections the practice is to start small fires in the holes made by blasting stumps and then haul the pieces to these fires. This is considered cheaper than it is to build a few large piles and not set them on fire until all the stumps are piled. Large stumps are very hard to pile.

Sometimes when white-pine stumps have been pulled whole by means of powerful pullers they are split by blasting. A small charge of dynamite is placed either in a hole bored into the base of the stump or in a notch chopped between two prominent roots. When placed between the roots, cover with earth the same as for mud capping bowlders. Often the heart of the stump is sufficiently decayed so that a charge may be placed in it. A small quantity of dynamite used in this manner will usually split the stump as well as a much larger charge would have done before the stump was pulled.

Where it is the plan not to pile the stumps within six months after pulling, it might be economical not to clean them when pulling, because during that period much of the earth will wash from the roots. Some pull the stumps in the fall and do not clean them until the following spring. It will be necessary, however, to clean the earth at the time of pulling from stumps pulled by a tripod machine.

Where stumps are hauled into big piles, it is important that they be free of earth. It has happened, especially where donkey engines have been used for piling, that so much dirt was hauled to the pile with the stumps that it was almost impossible to burn them, and after they were finally burned a big heap of earth was left to be hauled away.

A good method of piling is to use a piler with a swinging boom as shown in fig. 11. The mast of this piler is 30 feet high and the boom is 25 feet long. Using a gin pole, as shown in fig. 12, is a good plan. A few pilers have been made with a mast and boom constructed of iron pipe mounted on a wooden platform. In operating

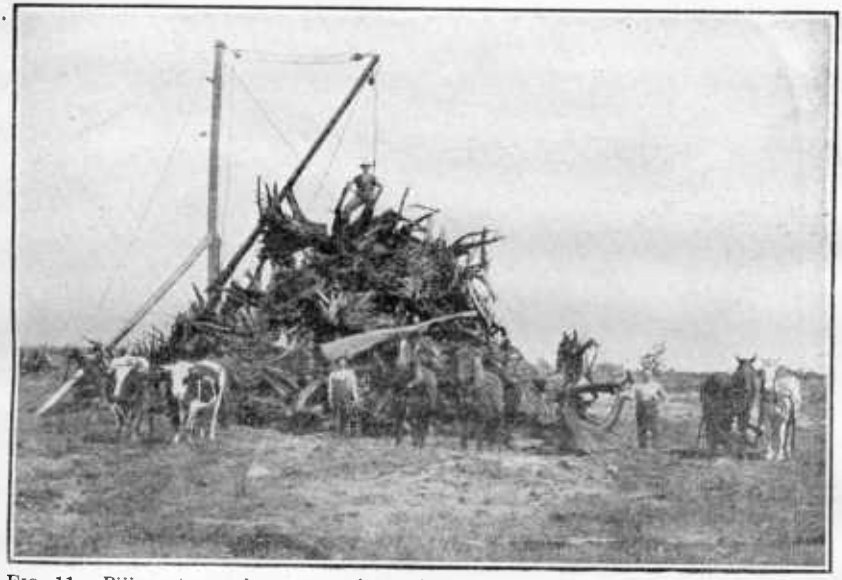

FIG. 11.—Piling stumps by means of a swinging boom piler. Using this outfit, four men with three teams piled and burned an average of 51 white pine stumps a day for 20 days. Dynamite was used under some of the largest stumps, 200 pounds being required on this 50-acre tract where 1,018 stumps were disposed of. A capstan puller with a crew of 3 men and a team was used in pulling, and averaged 23 a day.

this piler it can be hauled to a convenient place in the field, anchored, and earth thrown upon the frame to keep it from catching fire. A fire is built and the stumps hauled and deposited on the fire. The piling is continued while the fire is burning. This method has proved a very satisfactory one. Piling and burning at the same time can be carried on with a wooden piler, but there is danger of its catching fire. The work of piling stumps could be hastened materially by using some tripping device which would not necessitate the presence of a man on the stump pile. With some of the best donkey-engine outfits self-releasing chokers have been used. Hauling stumps to the piles can best be done when the ground is frozen hard. Loading on to a stone boat and hauling is a good way. Blocks and lines are useful in this work.

SOFTWOOD DISTILLATION PRODUCTS FROM STUMPS.

Many experiments have been made to reduce the stump by means of destructive distillation before it has been removed from the ground, but to date none of these methods has been successful. It has been found that the fir stump of the Northwest and the Norway pine of the Lake States yield too little of the products of softwood distillation such as turpentine, pine oil, tar, etc., to make their extraction commercially profitable. Longleaf pine stumps of the South

FIG. 12.—Pile of stumps and logs around a gin pole. These were piled by means of a donkey engine. The gin-pole method of piling could be used with a team.

yield large quantities of products which have been found valuable for numerous purposes. A number of plants of several different types have operated continuously in the South for many years; others have, from one cause or another, failed. When the price of turpentine goes below 40 cents a gallon and the price of rosin below $4 a barrel, the wood-distillation plants making these articles alone are usually forced to close. As the acreage of longleaf pine timber available for turpentining decreases, it is likely that there will be an increase in this industry. Only a small percentage of the farmers of the South, however, can hope to dispose of their pine stumps for distillation, because their lands are located too far from the distillation plants. Western yellow pine also contains valuable products, but as yet very little effort has been made to extract them in a commercial way.

Boring and blasting have been extensively used in getting stumps out of the ground for distillation. To get the best results when

blasting taprooted stumps, the charge must be placed within the taproot. To do this, a hole of sufficient size and deep enough to place the explosive at the center must be bored into the stump. The hole should be bored so deep that the center of the charge will be at or near the center of the taproot. (Fig. 13.) The hole should be started into the stump from about 10 inches below the surface (deeper if the stumps are to be used for distillation) and should slant downward at an angle of about 45°. Boring these holes by hand with a 1¼-inch or 1½-inch auger is heavy work. In some cases, when a ship auger is used, it will require two men.

Several turpentine companies who are using the stumps of the longleaf pine for distillation purposes have assembled outfits for boring these holes by means of electric drills, with power supplied by a dynamo run by a gasoline engine and mounted upon a wagon. It requires a crew of six to run this boring machine. They can bore from 300 to 500 stumps in a day. When operated continuously, the average cost per stump for the holes drilled will be about 3 cents. This cost takes into account repairs, depreciation, and interest, as well as operating expenses. An outfit of this kind could be utilized for boring the stumps for burning as described under the one-hole or dynamite methods (p. 11). However, these outfits cost at least $500 each (probably more under present abnormal conditions), and hence they are beyond the reach of the average farmer.

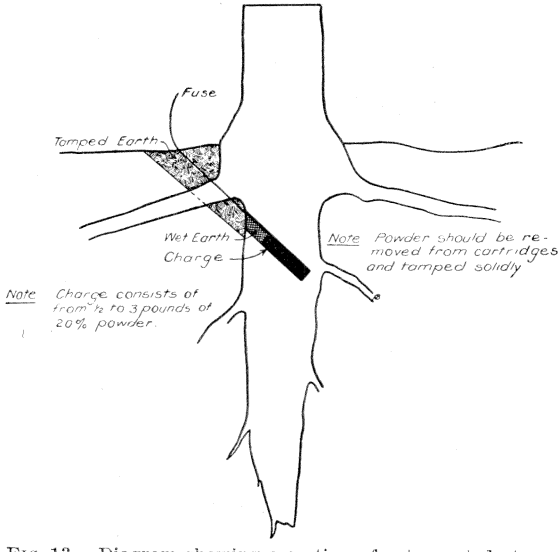

FIG. 13.—Diagram showing a section of a taprooted stump and a charge in position for blasting.

It has been found that the taproot, to a depth of about 30 inches, is quite as rich in valuable products as any part of the stump above ground. In order to remove the taproot to that depth by means of the boring and blasting method it is necessary to start the auger hole considerably more than 10 inches deep, which is deep enough for ordinary clearing.

Stump pullers and steam-power outfits have been used in pulling these stumps. With pullers all of the taproots can be obtained.

Where pullers are used it is advisable to split the stumps into pieces with dynamite so that they can be handled. Probably the 40 per cent dynamite is most often used, but some report that they prefer the 60 per cent grade for this purpose.

CHEMICALS WORTHLESS FOR REMOVING STUMPS.

So far as we have been able to learn, all experiments conducted to determine the value of sulphuric or nitric acid, either alone or combined, saltpeter, or nitrate of soda, as a means of destroying, or as an aid in burning stumps, have clearly demonstrated that these chemicals are worthless for this purpose.

BURNING LOGS.

Often logs are burned into desired lengths by boring a horizontal hole into the side and a vertical intersecting hole from the top. Coals are used to light a fire at the intersection of these holes. To split the log so it will be entirely burned, bore into the side and load with dynamite. Some bore from the top, but the horizontal hole is to be preferred because in the first case the force of the explosion separates the halves, while in the second the upper half lies close to the lower and the fire burns better. (See Decapitation Method, p. 12.)

FILLING HOLES AND DISPOSAL OF STONES.

Generally the holes made by the stump can easily be filled by the use of an ordinary two-horse walking plow and team. Where large stumps have been removed by heavy charges of dynamite the holes are so large that it may be necessary to use a scraper.

Where stones are plentiful a good method of disposing of them is to throw them into the stump holes. Burying bowlders too large to move is a common practice. An excavation large enough to contain the rock and cover it about 2 feet deep is made as close to the stone as can be done with safety and the stone is rolled into it.

Sometimes a bowlder can be broken by digging the earth away from it so that it will be exposed, building a good fire around it, and dashing cold water on it after it is thoroughly heated. Many rocks can be broken up by the use of a heavy sledge. Dynamite is very efficient as a means of breaking up bowlders. From 40 per cent to 60 per cent strength should be used, depending upon the method and the hardness of the rock. For detailed information on blasting bowlders the reader is referred to instructions issued by the manufacturers of explosives.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO CLEARING LAND.

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Outfit for Boring Taprooted Stumps for Blasting. (Farmers' Bulletin 600.) Price, 5 cents.

Cost and Methods of Clearing Land in Lake States. (Department Bulletin 91.) Price, 5 cents.

The Cost of Clearing Logged-off Land for Farming in the Pacific Northwest. (Bureau of Plant Industry Circular 25.) Price, 5 cents.

Cost and Methods of Clearing Land in Western Washington. (Bureau of Plant Industry Bulletin 239.) Price, 10 cents.